Chapter D1: Comparison of Costs and Benefits

INTRODUCTION

This chapter summarizes total private costs, develops social costs, and compares total social costs to total monetized benefits of the final rule at the national level. This chapter also presents a comparison of benefits and costs at the regional level.

Table D1-1 shows compliance action assumptions for the final rule based on each facility's currently installed technologies , capacity utilization, waterbody type, annual intake flow, and design intake flow as a percent of source waterbody mean annual flow. *Chapter A1: Introduction and Overview* of this EBA presents additional information on compliance responses under the final rule.

Table D1-1: Number of Facilities by Compliance Action[a]	
Facility Compliance Action	**Final Rule**
No compliance action[b]	200
Impingement controls only	149
Impingement and entrainment controls	205
Flow reduction technology	0
Total	554

[a] Alternative less stringent requirements based on both costs and benefits are allowed. There is some uncertainty in predicting compliance responses because the number of facilities requesting alternative less stringent requirements based on costs and benefits is unknown.

[b] These facilities already meet their compliance requirements. 75 facilities have a cooling tower in the baseline.

Source: U.S. EPA analysis, 2004.

D1-1 SOCIAL COSTS

This section develops EPA's estimates of the costs to society associated with the final rule. The **social costs** of regulatory actions are the **opportunity costs** to society of employing scarce resources in pollution prevention and pollution control activities. The compliance costs used to estimate total social costs differ in their consideration of taxes from those in *Part B: Costs and Economic Impacts*, which were calculated for the purpose of estimating the private costs and impacts of the rule. For the impact analyses, compliance costs are measured as they affect the financial performance of the regulated facilities and

firms. The analyses therefore explicitly consider the tax deductibility of compliance expenditures.[1] In the analysis of costs to society, however, these compliance costs are considered on a pre-tax basis. The costs to society are the full value of the resources used, whether they are paid for by the regulated facilities or by all taxpayers in the form of lost tax revenues.

To assess the economic costs to society of the final regulation, EPA relied first on the estimated costs to facilities for the labor, equipment, material, and other economic resources needed to comply with the final rule. In this analysis, EPA assumes that the market prices for labor, equipment, material, and other compliance resources represent the opportunity costs to society for use of those resources in regulatory compliance. EPA also assumes that the lost revenue from construction outages – which is recognized as a compliance cost – approximates the cost of the replacement energy that would be provided by other generating units. Implicit in this assumption is that the variable production cost of the replacement energy sources is essentially the same as the energy price received, on the margin, for production of the replacement energy. This assumption is consistent with the market equilibrium concept that the variable production cost of the last generating unit to be dispatched will be approximately the same as the price received for the last unit of production. Finally, EPA assumes in its social cost analysis that the regulation does not affect the aggregate quantity of electricity that would be sold to consumers and, thus, that the regulation's social cost will include no loss in consumer and producer surplus from lost electricity sales by the electricity industry in aggregate. Given the very small impact of the regulation on electricity production cost for the total industry, EPA believes this assumption is reasonable for the social cost analysis.

Other components of social costs include costs to federal and state governments of administering the permitting and compliance monitoring activities under the final regulation. *Chapter B5: UMRA Analysis* presents more information on state and federal implementation costs.

EPA's estimate of social costs includes three components:

- ▸ (1) direct costs of compliance incurred by in-scope facilities,
- ▸ (2) administrative costs incurred by state governments, and
- ▸ (3) administrative costs incurred by the federal government.

The estimated after-tax annualized compliance costs incurred by facilities under the final Phase II rule are $249.5 million, based on a seven percent discount rate (see *Chapter B1: Summary of Compliance Costs*, Table B1-6). The estimated social value of these compliance costs, calculated on a pre-tax basis is $385.1 million. EPA estimates that state implementation costs for the final rule are $4.0 million annually and that federal implementation costs are approximately $64,000. The estimated total social costs of the Final Phase II Existing Facilities Rule are therefore $389.2 million, based on a seven percent discount rate.

Table D1-2 summarizes the total private and social costs of the final rule, discounted at a seven percent rate. As a sensitivity analysis, the Appendix to this chapter presents total social costs discounted at a three percent discount rate.

---

[1] Costs incurred by government facilities and cooperatives are not adjusted for taxes, since these facilities are not subject to income taxes.

Table D1-2: Total Private and Social Costs of Compliance by Option (millions; $2002)					
Option	Total Private Compliance Costs to Facilities (Post-tax)	Social Costs[a]			
		Pre-Tax Compliance Costs to Facilities	State Implementation Costs	Federal Implementation Costs	Total Social Costs
Final Rule *Alternative less stringent requirements based on both costs and benefits are allowed.*	$249.5	$385.1	$4.0	$0.06	**$389.2**

[a]   All costs were annualized and discounted using a 7 percent rate.

Source: U.S. EPA analysis, 2004.

D1-2 SUMMARY OF NATIONAL BENEFITS AND SOCIAL COSTS

The summary of national benefit estimates for the final rule is reported in *Chapter C3: Monetized Benefits*. Table D1-3 presents EPA's national social cost and benefit estimates for the final Phase II rule. The benefits estimates in Table D1-3 were discounted using a 3 percent social discount rate (as a sensitivity analysis, the Appendix to this chapter presents total social benefits discounted at a seven percent discount rate). The table shows that estimated use benefits of the final rule are less than the social costs by $306 million. As noted in Chapter C3, the use benefits estimate includes monetized benefits to commercial and recreational fishing; however, since non-use benefits were estimated only qualitatively, the net benefits estimate presented here does not include non-use benefits. EPA notes that the Agency was not able to directly monetize benefits for 98.2% of the age-one equivalent losses of all commercial, recreational, and forage species for the section 316(b) Phase II regulation. This means that the benefits estimate used in this analysis represents the benefits associated with less than 2% of the total age-one equivalents lost due to impingement and entrainment by cooling water intake structures (CWIS) and should be interpreted with caution.

Table D1-3: Total National Social Costs, Benefits, and Net Benefits by Option (millions; $2002)[a]					
Option	Total Social Benefits[b]			Total Social Costs	Net Benefits Based on Use Benefits[c]
	Use Benefits	Non-use Benefits	Total Benefits		
Final Rule *Alternative less stringent requirements based on both costs and benefits are allowed.*	$82.9	n/a	n/a	$389.2	**($306.3)**

[a]   Benefits were discounted using a 3 percent social discount rate; costs were annualized and discounted using a 7 percent rate.
[b]   Use benefits presented in this table include commercial and recreational use benefits. Because EPA did not estimate non-use benefits quantitatively, the monetary value of total benefits could not be calculated.
[c]   The net benefits measure presented in this table is calculated by subtracting total social costs from total use benefits. This calculation is based on a comparison of a partial measure of social benefits with a complete measure of social costs and should be interpreted with caution.

Source: U.S. EPA analysis, 2004.

D1-3 REGIONAL COMPARISON OF BENEFITS AND SOCIAL COSTS FOR THE FINAL RULE

This section presents three measures that compare the monetized benefits and costs of the final rule at the regional level: (1) a benefit-cost analysis, including net benefits and benefit-cost ratio; (2) an analysis of the costs per age-one equivalent fish saved (equivalent to a cost-effectiveness analysis); and (3) a break-even analysis of the minimum non-use benefits required for total annual benefits to equal total annualized costs, on a per household basis. For each measure, benefits were discounted using a 3 percent social discount rate, while costs were annualized and discounted using the OMB Circular rate of 7 percent. EPA also conducted a sensitivity analysis, using a 7 percent discount rate for benefits and a 3 percent discount rate for costs, which is presented in the Appendix to this chapter. Each comparison measure is presented by study region.

D1-3.1 Benefit-Cost Analysis

The benefit-cost analysis compares total annualized monetized use benefits of the final rule to total social costs. The cost estimates include costs of compliance to facilities subject to the final rule as well as administrative costs incurred by state and local governments and by the federal government. As mentioned above, the benefits estimates include monetized benefits to commercial and recreational fishing, but do not include non-use benefits, which may be large (see Chapter C3 of this document for detailed benefits results). Thus, this analysis involves a comparison of a partial measure of social benefits with a complete measure of social costs and should be interpreted with caution. Table D1-4 below summarizes the benefits and costs of the final rule and presents the net benefits and the benefit-cost ratios, by study region.

Table D1-4: Summary of Annualized Social Benefits and Costs (millions; $2002)[a]					
Study Region[b]	**Total Social Benefits[c]**			**Total Social Costs[d]**	**Net Benefits (Based on Use Benefits)[e]**	**Benefit-Cost Ratio (Based on Use Benefits)[e]**
	Use Benefits	**Non-use Benefits**	**Total Benefits**			
California	$3.0	n/a	n/a	$31.7	($28.7)	0.09
North Atlantic	$1.4	n/a	n/a	$13.3	($11.9)	0.11
Mid-Atlantic	$45.0	n/a	n/a	$62.6	($17.5)	0.72
South Atlantic	$7.1	n/a	n/a	$9.0	($1.9)	0.79
Gulf of Mexico	$6.9	n/a	n/a	$22.8	($15.9)	0.30
Great Lakes	$14.1	n/a	n/a	$58.7	($44.6)	0.24
Inland	$3.0	n/a	n/a	$170.1	($167.2)	0.02
U.S. Total	**$82.9**	**n/a**	**n/a**	**$389.2**	**($306.3)**	**0.21**

[a]   Benefits were discounted using a 3 percent social discount rate; costs were annualized and discounted using a 7 percent rate.
[b]   Regional benefit and cost estimates are unweighted; total national estimates are sample-weighted and include costs and benefits for Hawaii.
[c]   Use benefits presented in this table include commercial and recreational use benefits. Because EPA did not estimate non-use benefits quantitatively, the monetary value of total benefits could not be calculated.
[d]   U.S. total annualized costs include $4.0 million in State and local administrative costs, and $0.06 in Federal administrative costs, that cannot be attributed to individual study regions.
[e]   The net benefits measure presented in this table is calculated by subtracting total social costs from total use benefits. The benefit-cost ratio is calculated by dividing total use benefits by total social costs. These calculations are based on a comparison of a partial measure of social benefits with a complete measure of social costs and should be interpreted with caution.

Source: U.S. EPA analysis, 2004.

Table D1-4 shows that the estimated total use benefits of the final rule are not projected to exceed total social costs in any of the regions. Without accounting for non-use values, the net social costs of the final rule are smallest in the South Atlantic region ($1.9 million) and largest in the Inland region ($167.2 million). Benefit-cost ratios are highest in the Mid-Atlantic and South Atlantic regions (0.7 and 0.8, respectively) and lowest in the Inland, California, and North Atlantic regions (0.02, 0.09, and 0.11 respectively). At the national level, EPA projects total social costs to exceed total use benefits, resulting in net benefits of -$306.3 million and a benefit-cost ratio of 0.2.

The Agency points out that EPA has produced a comparison of complete costs and incomplete benefits in the benefits cost analysis of the final section 316(b) regulation. A comparison of complete costs and incomplete benefits does not provide an accurate picture of net benefits to society. The regulation is expected to provide many benefits that were not accounted for in the benefits analysis by reducing impingement and entrainment (I&E) losses of fish, shellfish, and other aquatic organisms and, as a result, increase the numbers of individuals present, increase local and regional fishery populations (a subset of which was accounted for in the benefits analysis), and ultimately contribute to the enhanced environmental functioning of affected waterbodies (rivers, lakes, estuaries, and oceans) and associated ecosystems (see Chapter A9 of the Regional Case Study document for a detailed description of the ecological benefits from reduced I&E). The Agency believes that the economic welfare of human populations is expected to increase as a consequence of the improvements in fisheries and associated aquatic ecosystem functioning due to the final section 316(b) Phase II regulation.

D1-3.2 Cost per Age-One Equivalent Fish Saved – Cost-Effectiveness Analysis

EPA also analyzed the cost per organism saved as a result of compliance with the final rule. This analysis estimates the cost-effectiveness of the rule, by study region. Organisms saved are measured as "age-one equivalents" (the number of individuals of different ages impinged and entrained by facility intakes expressed as age-one). The costs used in this comparison are the annualized social costs of the final rule.

Table D1-5 below shows that the estimated cost per age-one equivalent ranges from seven cents in the Mid Atlantic region to $1.46 in the Inland region. At the national level, the estimated cost is 27 cents per age-one equivalent saved.[2]

Table D1-5: Annualized Cost per Age-one Equivalent Saved			
Study Region[a]	Total Social Costs (millions; $2002)	Age-One Equivalents (millions)	Cost/Age-One Equivalent
California	$31.7	66.4	$0.48
North Atlantic	$13.3	19.3	$0.69
Mid-Atlantic	$62.6	846.4	$0.07
South Atlantic	$9.0	76.7	$0.12
Gulf of Mexico	$22.8	89.5	$0.25
Great Lakes	$58.7	159.5	$0.37
Inland	$170.1	116.8	$1.46
U.S. Total	**$389.2**	**1,420**	**$0.27**

[a]   Regional benefit and cost estimates are unweighted; total national estimates are sample-weighted and include Hawaii.
[b]   U.S. total annualized costs include $4.0 million in State and local administrative costs, and $0.06 in Federal administrative costs, that cannot be attributed to individual study regions.

Source: U.S. EPA analysis, 2004.

---

[2] It should be noted that the national numbers include costs for the three facilities in Hawaii but do not include any benefits that may result from their compliance with the final rule.

D1-3.3 Break-Even Analysis

Estimating non-use values is an extremely challenging and uncertain exercise, particularly when primary research using stated preference methods is not a feasible option (as is the case for this rulemaking). In Chapter A12 of the *Regional Analysis Document for the Final Section 316(b) Existing Facilities Rule* (U.S. EPA, 2004), EPA described possible alternative approaches for developing non-use benefit estimates based on benefits transfer and associated methods. Due to the uncertainties of providing estimates of the magnitude of non-use values associated with the final rule, this section provides an alternative approach of evaluating the potential magnitude of non-use values. The approach used here applies a "break-even" analysis to identify what non-use values would have to be in order for the final rule to have benefits that are equal to costs.

The break-even approach uses EPA's estimated commercial and recreational use benefits for the rule and subtracts them from the estimated annual compliance costs incurred by facilities subject to the final rule. The resulting value enables one to work backwards to estimate what non-use values would need to be (in terms of willingness to pay per household per year) in order for total annual benefits to equal annualized costs. Table D1-6 below provides this assessment for the seven study regions.

Table D1-6: Implicit Uncaptured Benefits - Break-Even Analysis (millions; $2002)[a]					
Study Region[b]	**Use Benefits**	**Total Social Costs[c]**	**Non-use Benefits Necessary to Break Even[d]**	**Number of Households[e]**	**Break-Even WTP per Household**
California	$3.0	$31.7	$28.7	8,093,185	$3.55
North Atlantic	$1.4	$13.3	$11.9	3,932,827	$3.02
Mid-Atlantic	$45.0	$62.6	$17.5	9,626,354	$1.82
South Atlantic	$7.1	$9.0	$1.9	3,817,567	$0.50
Gulf of Mexico	$6.9	$22.8	$15.9	5,421,104	$2.92
Great Lakes	$14.1	$58.7	$44.6	8,628,825	$5.17
Inland	$3.0	$170.1	$167.2	20,908,109	$8.01
U.S. Total	**$82.9**	**$389.2**	**$306.3**	**60,427,971**	**$5.07**

[a] Benefits were discounted using a 3 percent social discount rate; costs were annualized and discounted using a 7 percent rate.
[b] Regional benefit and cost estimates are unweighted; total national estimates are sample-weighted.
[c] U.S. total annualized costs include $4.0 million in State and local administrative costs, and $0.06 in Federal administrative costs, that cannot be attributed to individual study regions.
[d] The non-use benefits category in this table may include some categories of use values that were not taken into account by the recreation and commercial fishing analyses.
[e] Includes anglers fishing in the region and households in abutting counties (BLS, 2000).

Source: U.S. EPA analysis, 2004.

As shown in Table D1-6 above, for total annual benefits to equal total annualized costs, non-use values per household would have to be between $0.50 in the Gulf of Mexico region and $8.01 in the Inland region. This estimate assumes that only anglers fishing in the region and households in abutting counties have non-use values for the affected resources. At the national level, the annual non-use willingness to pay per household would have to be $5.07 for total annual benefits to equal total annualized costs.

GLOSSARY

opportunity cost: The lost value of alternative uses of resources (capital, labor, and raw materials) used in pollution control activities.

social costs: The costs incurred by society as a whole as a result of the final rule. Social costs do not include costs that are transfers among parties but that do not represent a net cost overall.

§ 316(b) Phase II Final Rule – EBA, Part D: National Benefit-Cost Analysis   D1: Comparison of National Costs and Benefits

D1-7

REFERENCES

U.S. Department of Commerce, Bureau of the Census, Bureau of Labor Statistics (BLS). 2000. "Summary File 1."
http://www.census.gov/Press-Release/www/2001/sumfile1.html.

U.S. Environmental Protection Agency (U.S. EPA). 2004. *Regional Studies for the Final Section 316(b) Phase II Existing Facilities Rule*. EPA-821-R-04-006. February 2004.

§ 316(b) Phase II Final Rule – EBA, Part D: National Benefit-Cost Analysis   D1: Comparison of National Costs and Benefits

D1-8

Appendix to Chapter D1

This appendix presents the results of the benefit-cost analysis (Section D1-3.1 above) and the break-even analysis (Section D1-3.2 above) but using a seven percent discount rate for benefits, instead of a three percent rate, and using a three percent discount rate for costs, instead of seven percent. The results of this sensitivity analysis are presented in the following tables. In the portions of this sensitivity analysis that present a three percent rate for costs, EPA discounted the total costs of the rule at three percent but annualized them at seven percent. The three percent rate is the social discount rate that is used to determine the total present value to society of the regulatory costs and benefits incurred in the future. The seven percent annualization rate reflects the real cost of capital to complying facilities.

Study Region[a]	Total Social Benefits[b]			Total Social Costs[c]	Net Benefits (Based on Use Benefits)[d]	Benefit-Cost Ratio (Based on Use Benefits)[d]
	Use Benefits	Non-use Benefits	Total Benefits			
Table D1-A-1: Summary of Annualized Social Benefits and Costs (millions; $2002)						
Benefits discounted at 3 percent; costs discounted at 3 percent.						
California	$3.0	n/a	n/a	$33.1	($30.1)	0.09
North Atlantic	$1.4	n/a	n/a	$14.9	($13.5)	0.10
Mid-Atlantic	$45.0	n/a	n/a	$69.1	($24.0)	0.65
South Atlantic	$7.1	n/a	n/a	$10.1	($3.0)	0.70
Gulf of Mexico	$6.9	n/a	n/a	$25.4	($18.5)	0.27
Great Lakes	$14.1	n/a	n/a	$66.1	($51.9)	0.21
Inland	$3.0	n/a	n/a	$183.7	($180.7)	0.02
U.S. Total	**$82.9**	**n/a**	**n/a**	**$426.0**	**($343.1)**	**0.19**
Benefits discounted at 7 percent; costs discounted at 7 percent.						
California	$2.3	n/a	n/a	$31.7	($29.4)	0.07
North Atlantic	$1.2	n/a	n/a	$13.3	($12.1)	0.09
Mid-Atlantic	$39.9	n/a	n/a	$62.6	($22.6)	0.64
South Atlantic	$6.4	n/a	n/a	$9.0	($2.6)	0.71
Gulf of Mexico	$6.2	n/a	n/a	$22.8	($16.6)	0.27
Great Lakes	$12.4	n/a	n/a	$58.7	($46.4)	0.21
Inland	$2.6	n/a	n/a	$170.1	($167.6)	0.02
U.S. Total	**$72.9**	**n/a**	**n/a**	**$389.2**	**($316.2)**	**0.19**

[a]   Regional benefit and cost estimates are unweighted; total national estimates are sample-weighted and include costs and benefits for Hawaii.

[b]   Use benefits presented in this table include commercial and recreational use benefits. Because EPA did not estimate non-use benefits quantitatively, the monetary value of total benefits could not be calculated.

[c]   U.S. total annualized costs include $4.0 million in State and local administrative costs, and $0.06 in Federal administrative costs, that cannot be attributed to individual study regions.

[d]   The net benefits measure presented in this table is calculated by subtracting total social costs from total use benefits. The benefit-cost ratio is calculated by dividing use benefits by total social costs. These calculations are based on a comparison of a partial measure of social benefits with a complete measure of social costs and should be interpreted with caution.

Source: U.S. EPA analysis, 2004.

Table D1-A-2: Implicit Uncaptured Benefits - Break-Even Analysis (millions; $2002)[a]					
Study Region[a]	Use Benefits	Annualized Social Costs[b]	Uncaptured Benefits Necessary to Break Even	Number of Households[c]	Break-Even WTP per Household
Benefits discounted at 3 percent; costs discounted at 3 percent.					
California	$3.0	$33.1	$30.1	8,093,185	$3.72
North Atlantic	$1.4	$14.9	$13.5	3,932,827	$3.43
Mid-Atlantic	$45.0	$69.1	$24.0	9,626,354	$2.50
South Atlantic	$7.1	$10.1	$3.0	3,817,567	$0.80
Gulf of Mexico	$6.9	$25.4	$18.5	5,421,104	$3.42
Great Lakes	$14.1	$66.1	$51.9	8,628,825	$6.02
Inland	$3.0	$183.7	$180.7	20,908,109	$8.64
U.S. Total	**$82.9**	**$426.0**	**$343.1**	**60,427,971**	**$5.68**
Benefits discounted at 7 percent; costs discounted at 7 percent.					
California	$2.3	$31.7	$29.4	8,093,185	$3.63
North Atlantic	$1.2	$13.3	$12.1	3,932,827	$3.08
Mid-Atlantic	$39.9	$62.6	$22.6	9,626,354	$2.35
South Atlantic	$6.4	$9.0	$2.6	3,817,567	$0.68
Gulf of Mexico	$6.2	$22.8	$16.6	5,421,104	$3.06
Great Lakes	$12.4	$58.7	$46.4	8,628,825	$5.37
Inland	$2.6	$170.1	$167.6	20,908,109	$8.01
U.S. Total	**$72.9**	**$389.2**	**$316.2**	**60,427,971**	**$5.23**

[a]   Regional benefit and cost estimates are unweighted; total national estimates are sample-weighted.
[b]   U.S. total annualized costs include $4.0 million in State and local administrative costs, and $0.06 in Federal administrative costs, that cannot be attributed to individual study regions.
[c]   Includes anglers fishing in the region and households in abutting counties (BLS, 2000).

Source: U.S. EPA analysis, 2004.

THIS PAGE INTENTIONALLY LEFT BLANK

§ 316(b) Phase II Final Rule – EBA, Part D: National Benefit-Cost Analysis   D1: Comparison of National Costs and Benefits

D1-12